

## What is claimed is:

[Claim 1] A method of forming an interconnect structure comprising:  
providing a lead free solder joint;  
providing a lead-containing solder;  
aligning said lead free solder joint with said lead-containing solder;  
heating said aligned lead free solder joint and lead-containing solder to a temperature above a melting point of said lead free solder joint for a sufficient time to allow for complete homogenization of said lead free solder joint with said lead-containing solder to form a homogenous hybrid interconnect structure.

[Claim 2] The method of claim 1 wherein said lead free solder joint comprises a material selected from the group consisting of Sn-Ag (SA), Sn-Ag-Sb, Sn-Ag-Bi, Sn-Ag-Cu (SAC), Sn-Ag-Cu-Sb, Sn-Ag-Cu-Bi, Sn-Ag-Bi-Sb, Sn-Cu (SC), Sn-Cu-Sb, Sn-Cu-Bi, Sn-Ag-Cu-Sb-Bi or combinations thereof.

[Claim 3] The method of claim 1 wherein said lead free solder joint comprises a material selected from the group consisting of Sn-Zn, Sn-Zi-Bi, Sn-In, Sn-Bi, Sn-Ag-In, Sn-Ag-In-Cu or combinations thereof.

[Claim 4] The method of claim 1 wherein said lead-containing solder is selected from the group consisting of a lead-containing solder paste, a lead-containing solder paste with organic flux, or a lead-containing solder paste without organic flux.

[Claim 5] The method of claim 1 wherein said lead-containing solder comprises a tin-lead paste.

[Claim 6] The method of claim 1 wherein said temperature ranges from above 217°C to about 260°C.

[Claim 7] The method of claim 6 wherein said sufficient time ranges from about 1 minute to about 4 minutes.

[Claim 8] The method of claim 1 wherein said homogenous hybrid interconnect structure has a configuration characterized by having no distinct regions of said lead free solder joint and said lead-containing solder.

[Claim 9] A method of forming an interconnection grid array structure comprising:

providing an interconnection grid array of lead free solder joints;  
providing an array of lead-containing solder, said array of lead-containing solder corresponding to said interconnection grid array of lead free solder joints;  
aligning said interconnection grid array of lead free solder joints with said array of lead-containing solder;  
heating said aligned interconnection grid array of lead free solder joints and said array of lead-containing solder to a temperature above a melting point of said lead free solder joints for a sufficient time to allow for complete melting and mixing together of said interconnection grid array of lead free solder joints and said array of lead-containing solder such that lead from said lead-containing solder disperses throughout said interconnection grid array of lead free solder joints to form a homogenous hybrid interconnect grid array having improved, reliable levels of thermo-mechanical fatigue.

[Claim 10] The method of claim 9 wherein said interconnection grid array of lead free solder joints comprise a material selected from the group consisting of Sn-Ag, Sn-Ag-Sb, Sn-Ag-Bi, Sn-Ag-Cu, Sn-Ag-Cu-Sb, Sn-Ag-Cu-Bi, Sn-Ag-Bi, Sn-Ag-Bi-Sb, Sn-Cu, Sn-Cu-Sb, Sn-Cu-Bi or combinations thereof.

[Claim 11] The method of claim 9 wherein said interconnection grid array of lead free solder joints comprise a material selected from the group consisting of Sn-Zn, Sn-Zi-Bi, Sn-In, Sn-Bi, Sn-Ag-In, Sn-Ag-In-Cu or combinations thereof.

[Claim 12] The method of claim 9 wherein said array of lead-containing solder is selected from the group consisting of an array of lead-containing solder paste, an array of lead-containing solder paste with organic flux, or an array of lead-containing solder paste without organic flux.

[Claim 13] The method of claim 12 wherein said array of lead-containing solder comprises a tin-lead paste.

[Claim 14] The method of claim 9 wherein said homogenous hybrid interconnect grid array is formed at temperature ranges from above 217°C to about 260°C for said sufficient time ranging from about 1 minute to about 4 minutes.

[Claim 15] The method of claim 9 wherein solder joints of said homogenous hybrid interconnect grid array have configurations characterized by having no distinct regions of said lead free solder joint and said lead-containing solder.

[Claim 16] The method of claim 15 wherein said configurations of said solder joints are substantially oblate ellipsoid shapes.

[Claim 17] An assembly having an interconnection grid array comprising:  
a first substrate;  
a second substrate; and

a homogenous hybrid interconnect grid array joining said first and second substrates, said homogenous hybrid interconnect grid array having a plurality of hybrid solder joints each composed of a homogenous mixture of a lead free solder and a lead-containing solder, whereby said homogenous hybrid interconnect grid array has improved, reliable levels of thermo-mechanical fatigue.

[Claim 18] The assembly of claim 17 wherein said lead free solder comprises a material selected from the group consisting of Sn-Ag, Sn-Ag-Sb, Sn-Ag-Bi, Sn-Ag-Cu, Sn-Ag-Cu-Sb, Sn-Ag-Cu-Bi, Sn-Ag-Bi, Sn-Ag-Bi-Sb, Sn-Cu, Sn-Cu-Sb, Sn-Cu-Bi, Sn-Zn, Sn-Zi-Bi, Sn-In, Sn-Bi, Sn-Ag-In, Sn-Ag-In-Cu or combinations thereof.

[Claim 19] The assembly of claim 18 wherein said lead-containing solder comprises a tin-lead paste.

[Claim 20] The assembly of claim 17 wherein said plurality of hybrid solder joints of said homogenous hybrid interconnect grid array have configurations characterized by having no distinct regions of said lead free solder and said lead-containing solder.